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Hamelink, F.; Hoesli, M.

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# SERIE RESEARCH MEMORANDA

## **What factors determine international real estate security returns?**

Foort Hamelink  
Martin Hoesli

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# What factors determine international real estate security returns?

Foort Hamelink\* and Martin Hoesli\*\*

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## Abstract

In this paper, we use constrained cross-section regressions to disentangle the **effects** of various factors on **real** estate security returns in 21 countries. A better knowledge of the risk factors driving **real** estate returns is **crucial**, whether a pure **real** estate portfolio is constructed, or whether **real** estate is considered as an alternative **asset class** within the traditional stock portfolio. Besides a common factor, “pure” country, **size**, and **value/growth** factors are considered. The **value/growth** measure that is used in this paper is a unique indicator developed by Salomon Smith Barney (SSB). It **provides** for **each** stock the relative importance of the **value** and growth **components**, **rather** than **using** a binary classification. The **value/growth** factor is **found** to have a substantial **and** increasing effect on returns over the analyzed period February 1990-April 2002. Country factors are important **determinants** of **real** estate security returns **also**. Statistical analysis of the residuals **indicates** that additional “hidden” factors most likely exist. These statistical factors are **shown** to explain about one third of **specific** returns on international **real** estate securities. Nevertheless, as is the case for traditional stock portfolios, stock picking keeps **all** its **importance** for **real** estate stocks as well.

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\* Lombard Odier & Cie (Geneva), Vrije Universiteit (Amsterdam) and FAME, email: [foort@hamelink.com](mailto:foort@hamelink.com)

\*\* University of Geneva (HEC and FAME) and University of Aberdeen (Department of Accountancy & Finance), email: [martin.hoesli@hec.unige.ch](mailto:martin.hoesli@hec.unige.ch)

Please **address** correspondence to: Martin Hoesli, University of Geneva, HEC, 40 boulevard du Pont-d'Arve, CH-1211 Geneva 4, Switzerland.

Substantial work on **this** paper was undertaken while the **second** author was the Hans Dalborg visiting professor of **financial** economics, Stockholm **Institute** for Financial Research (SIFR), Sweden. The paper benefited **from** **useful** **comments** **from** Peter Englund (SIFR and Stockholm School of Economics), Åke Gunnelin and Göran Robertsson (SIFR), and **participants** at the **European** **Real** Estate Society conference in Glasgow.

# What factors determine international real estate security returns?

## 1. Introduction

For stock portfolio managers executing a top-down approach it is **crucial** to **decide** whether the strategy **will** be based primarily on countries, sectors, industries, or some other factor **such** as **size** or **value/growth**. Diversification by sectors is growing in **importance**, but geographical allocation remains important despite the globalization of international financial **markets**. In this context, **real** estate securities are considered as one industry, but are too **often** discarded **from** the **strategic** portfolio allocation. This is surprising **given** that **real** estate securities have been shown to be **an effective diversifier** of common stock portfolios (Liang et al., 1996; Gordon et al., 1998). Moreover, the correlation of U.S. **REITs** with common stocks has been declining (Khoo et al., 1993; Ghosh et al., 1996). **Also**, the market value of publicly traded **real** estate **companies** has grown substantially in recent years (approximately **US\$ 400 billion** as of the end of 1999, as reported by Ling and Naranjo, 2002).

Extensive research has been conducted since the 1970s on the **benefits** of international **diversification** for stock portfolios. There is **also** more recent **evidence** on the benefits of international diversification both for portfolios of direct and indirect **real** estate investments. The cross-country correlations are usually lower for **real** estate investments than for common stocks. There is **evidence, however**, of **an** international **real** estate factor (Ling and Naranjo, 2002), and **also** of continental factors (Eichholtz et al., 1998). Country-specific factors remain important, **however**, which explains the diversification **benefits**.

**When** constructing a portfolio of publicly traded **real** estate stocks, **much** emphasis is **placed** on the analysis of the correlation coefficients **across** countries (or **across** continents). We argue **that** while these correlations are **useful**, it would be important to disentangle the **effects** of various factors on **real** estate company returns and hence on cross-country correlation coefficients. The aim of this paper is to **calculate** the “**pure**” **effects** of various factors on international **real** estate security returns. For this purpose we use **real** estate security returns for 21 countries for the period from February 1990 to April 2002, and extract **such** “**pure**” **effects** using a cross-sectional factor estimation technique. The factors that we consider are

the following: a common factor **affecting all** securities, the **well known size** effect **first** analyzed by **Banz** (1981), the **value/growth** factor of **Fama** and French (1992), and the country of origin of the security. Cluster analysis and **principal** component analysis (PCA) are used on the residuals of this analysis to ascertain whether **an** additional factor **can** be **extracted**, **once** the effect of the common and “pure” factors has been eliminated. The relative **importance** of the common factor and that of **each** “pure” factor is highlighted. **Such an** analysis is of great **importance** as changes in cross-country correlation coefficients **may** be due to changes in **any** of the other factors. By extracting the **influence** of other factors on cross-country correlations, it is possible to ascertain the true potential of international **real** estate portfolio diversification.

The paper is organized as follows. In section 2, we **discuss** related work on international **real** estate diversification. **In** section 3, we present our data and **also evidence** on the **usefulness** of **real** estate in **diversifying** a stock portfolio. The method that we use to assess the risk of **real** estate portfolios is **discussed** in section 4. **Section** 5 contains our results, and section 6 some concluding remarks.

## 2. International Real Estate Diversification

The issue of international diversification of stock portfolios has **received** substantial attention in the **financial** economics literature since the seminal work by **Solnik** (1974). The **general conclusion** is that widening the investment spectrum to non-domestic stocks permits **an** increase in risk-adjusted returns. Moreover, geographical diversification has been shown to be more **effective** than diversification by industry (**Heston** and Rouwenhorst, 1994 and 1995). Recent work has shown that the world **economy** is becoming increasingly global, with international stock **markets** becoming more and more correlated with **each** other (**Solnik** and Roulet, 1999). **In such** a context, industrial factors have gained in **importance** (Cavaglia et al., 2000; Hamelink et al., 2001).

Far less attention has been given to this issue in the **real** estate **literature** due to the relative **lack** of quality international data on the performance of **real** estate. Case et al. (1997) **find** that returns to commercial **real** estate tend to move together (although not perfectly) **across** property types within **each** country, and that **international** diversification within three segments of the **real** estate market (industrial, office and retail) would have been **beneficial**

over the period 1986-1994. Quan and Titman (1997) report that U.S. **real** estate correlations are lower than those of stock returns, suggesting significant **benefits from** international **real** estate diversification (see **also** Newell and Webb, 1996). Goetzmann and Wachter (1999) **also** find that cross-border **real** estate diversification is **useful**. They show that cross-border correlations are due in part to common exposure to fluctuations in the global **economy**, but that country-specific GDP **changes** help explain more of the variation in **real** estate returns **than** the global factor. This would indicate a stronger impact of local **factors** than has been reported for common stocks (**Beckers et al.**, 1996). **Goetzmann** and Wachter (1999) report that international **real** estate diversification is more beneficial than international stock diversification for industrial **real** estate, but not for other property types. Several studies have **also** looked at whether international **real** estate **portfolios** should be hedged against currency fluctuations (see e.g. **Ziobrowski et al.**, 1997). The results concerning the **usefulness** of hedging are mixed. **When** it is decided to hedge, then currency swaps have been shown to be best suited given the long term **nature** of **real** estate investments.

Securitized **real** estate has been shown to be **quite** highly correlated with common stocks on an international basis (Eichholtz, 1997), although there is **evidence** for U.S. REITs that this correlation has been declining (Khoo *et al.*, 1993; Ghosh *et al.*, 1996). **Also**, and as is the case for direct **real** estate (**Goetzmann** and Wachter, 1999), there is **evidence** of a world-wide factor in international indirect **real** estate returns (Ling and Naranjo, 2002). The **latter authors** **also** find that a country-specific factor is highly significant, which would suggest that **international** diversification is **useful when** constructing portfolios of **real** estate securities. Eichholtz *et al.* (1998) find **clear evidence** of a continental factor in Europe and in North **America**, but not in the **Asia-Pacific** region. Their results **also** suggest growing integration within Europe. This **result** would seem to indicate that a parsimonious international **real** estate security diversification strategy is most beneficial **when** conducted **across continents** **rather** than within **continents**.

Correlations of **real** estate securities **across** countries are lower than cross-border correlations between common stocks (Eichholtz, 1996a; **Gordon et al.**, 1998). Eichholtz (1996a) additionally **finds** that international **real** estate security diversification is more **effective** than international stock diversification. **Wilson** and Okunev (1996) use cointegration tests and show that international **real** estate **markets** are segmented. **Benefits** are to be gained **from** diversification, although potential gains are dependent on the exchange **rate** risk. Stevenson

(2000) **also** reports **evidence** on the benefits of international diversification for **real** estate security portfolios (although he finds that these benefits are greater for common stocks), and on the positive impact of including international **real** estate stocks in global equity portfolios (see **also** Liu and Mei, 1998).

### **3. Data and Analysis of the Role of Real Estate Stocks in Diversifying Stock Portfolios**

In this section, we present the data that we use (3.1), and **also** make the case for the **usefulness** of **real** estate securities in **diversifying** common stock portfolios (3.2).

#### **3.1 Data**

We use **all real** estate stocks included in the Salomon Smith Barney (SSB) Developed World Equity database for the period February 1990-April 2002. Countries **that** have at least one **real** estate security in the SSB database as of the end of April 2002 are retained, leading to a total of 21 **countries**. Total returns calculated on **monthly time** increments are available from the database. To conduct various **comparative** analyses, we **also** use stock market index data for the same **countries**. The source of the data is **also** SSB. All returns are in **US\$**. We use unhedged returns as we consider that **this** is the most realistic assumption: in most cases the benchmark against which the portfolio manager is evaluated is unhedged. This generally **makes** sense, as for a **well** diversified international benchmark the currency risk **tends** to be diversified away. Therefore, practitioners **who decide** to include **real** estate stocks in their portfolio **will** hardly **decide** to hedge these positions. As unhedged returns are used, the currency **effects** **will** be included in the “pure” country **effects**. In **this framework**, an exposure to a given country entails an exposure to the country’s currency.

This database entails two major advantages as compared to other databases. First, it contains **every** company whose available equity capitalization or float is greater than **US\$** 100 million. So all shares that **can** be realistically purchased by institutional **investors** are considered. **Another** major advantage of **this** database is that for **each** stock a **growth** and a value weight is provided; the total of weights for **each** stock being equal to one. **Any** given stock is therefore not either a growth stock or a value stock as is the case **when** other style classifications are used, but is some combination of both attributes. We **discuss** the method used by SSB to **compute** the growth and value weights later in this section. There are **also** two drawbacks

from using this database: (1) no indication is given on **the** type of **real** estate company (investment, trading, or development), and (2) the company's **main** investment focus (**residential**, office, **retail**, etc.) is not reported. These variables **can** therefore not be considered in the analysis. It is hypothesized that some of the impact of these missing characteristics is **captured** by the country, growth, and **size** variables, with the remaining **effects** appearing in the specific return component. Statistical techniques are used in this paper to examine whether additional **factors** **can** be **extracted** from the **specific** component.

Summary **statistics** for **real** estate securities are presented in *Table 1*. The continental returns are **computed** as the weighted **average** of returns in the constituent countries. As of the end of April 2002, the total number of **real** estate securities included in the database **amounts** to 337, and **the** market capitalization to approximately **US\$ 280** billion. The **five** largest countries in terms of market capitalization account for 86.8% of total market capitalization as of **the** end of April 2002. This table **also** shows that the market capitalization of **real** estate stocks as a percentage of the market capitalization of common stocks included in the SSB database **varies quite** substantially **from** one country to another, with Hong Kong and to a lesser extent Australia, Singapore, and Austria exhibiting high ratios. *Figure 1* shows the **evolution** of the number of **real** estate stocks included in the SSB database, and **also** of securitized **real** estate market capitalization. Market capitalization has increased substantially over the period (see **also** Eichholtz and Koedijk, 1996). The number of **companies** in the SSB database has increased **from** 146 in 1990 to 396 in August 1997, but has diminished in recent years.

**< INSERT TABLE 1 HERE >**

**< INSERT FIGURE 1 HERE >**

*Table 1* **also** reports the **average** growth probability weight of **real** estate stocks in **each** country, continent, **and** globally. The growth and value probability weights of **each** company are reported on a 0 to 1 **scale** by Salomon Smith Barney. For **each** company, the total of the growth and value weights is 1. The procedure that is used by SSB is as follows (Salomon **Smith** Barney, 2000). First, a set of 10 variables related to growth, and a set of **five** variables **related** to value are identified. As these variables have different measurement units, **they** have to be standardized. Standardization **also** **leads** to all variables **having** approximately the same **influence upon** the measurement of the style characteristics. **Ideally**, standardization should be undertaken on a world-wide basis, but this is impossible as different accounting **principles**



prevail across countries. Thus, standardization is **undertaken** by country **when** the number of companies is sufficiently large, else it is achieved by groupings of **countries** that are geographically and culturally similar and that have similar accounting **standards** (an example of one **such** grouping is **Denmark**, Finland, Norway, and Sweden). Cluster analysis is then applied to **both** sets of variables, and three growth and four value variables are retained. The growth variables are:

- **5-year** earnings per share growth **rate**;
- **5-year** sales per share growth **rate**;
- **5-year internal** growth **rate** = ROE x (1 - payout ratio);

and the value variables:

- book value to price;
- cash flow to price;
- sales to price;
- dividends to price (yield).

Growth and value scores are **computed** for **each** stock as the equally weighted **average** of the value of these variables. A stock that is clearly either a growth or a value stock, **will** be considered as a pure growth or **value** stock, and assigned a probability weight of 1 for that characteristic. If a stock is not clearly a growth or a value stock, the weight is split according to distances **from** pure growth and value stocks. The **final** step is to ensure that (1) **each** SSB country style index represents exactly 50% of the total **float-adjusted** market capitalization of the corresponding country', and (2) for **each** stock, the sum of probability weights is equal to 1. The above procedure is applied **each** year in June.

*Figure 2* depicts the **average** weight of the growth factor (on a **scale** from 0 to 1) for **real** estate companies in the various **continents** and on a world-wide basis for the period **from** February 1990 to April 2002. **Real** estate companies have become less and less growth companies (as defined by SSB) over the **1990s**, with relatively large swings **during** the beginning of the current decade for Asian and Ckeania **real** estate stocks. **Real** estate companies appear to be clearly less growth companies at the end of the period as compared to what was the case at the beginning of the period.

**< INSERT FIGURE 2 HERE >**

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<sup>1</sup> Ideally, the measurement of growth **and** value weights should not be country-specific, but global. As stated above, this is **hardly** possible **due to different** accounting **practices** across countries, and SSB have decided to measure the probability **weights within** countries. It is acknowledged **here** that **biases may occur** if the **relative importance** of growth **and** value **dimensions varies** dramatically **from** one country to **another**.

### 3.2 The Case for Real Estate Securities in the Portfolio

Several **facts** have been reported in previous research. First, **real** estate securities have been shown to be **effective** diversifiers for portfolios of stocks **and** bonds (Gordon et *al.*, 1998). **Second**, the beta of **real** estate securities on the **general** stock index has been declining, indicating that **real** estate securities are less and less tied **to** the general stock market (Khoo et *al.*, 1993; Ghosh et *al.*, 1996), which would suggest that diversification opportunities have increased. Third, the benefits of international diversification appear to be greater than what is the case for common stocks (Eichholtz, 1996a). Finally, international **real** estate securities have been shown to act as **portfolio** diversifiers, even in portfolios containing international stocks (Gordon et *al.*, 1998).

In this **section**, we investigate the ability of **real** estate stocks to **diversify** a stock portfolio using our database of international **real** estate securities. We thus **provide** up-to-date **evidence** on the usefulness of **real** estate stocks in **diversifying** stock portfolios, which supports the **in**-depth analysis of international **real** estate diversification that is conducted in the subsequent two sections. We first **compute** rolling betas of the **real** estate security indices on the **general** stock indices for the **five** largest countries in terms of current market capitalization (the U.S., Hong Kong, the U.K., Australia, and Japan). We use a **36-month** moving window that is shifted by one **month** for **each** regression. The rolling betas show whether the degree of association between **real** estate stocks and common stocks is **time-varying**. We **also** **compute** cross-country correlation coefficients, both for **real** estate securities and common stocks. The ten countries that have **the** largest market capitalization in **real** estate securities are considered (i.e. in addition to the above **five** countries, the Netherlands, Canada, **France**, Singapore, and Sweden). Rolling **average** correlation **coefficients** **across** **the** 10 countries are **also** analyzed, both for **real** estate stocks and common stocks. This analysis sheds light on the integration of international **real** estate security and stock **markets**, respectively. Finally, we investigate the increase in tracking error for a portfolio manager **when** **real** estate securities are included in a stock portfolio. **Such** an analysis is important for portfolio managers **who** include **real** estate in their portfolio but **who** have nevertheless a pure stock index as benchmark. Increasing the exposure **to** **real** estate **may** add some additional return to the total portfolio and lower the standard deviation of the portfolio, but **will** **also** increase **the** tracking error **when** performance is measured against **such** a benchmark.

*Figure 3* shows the 36-month rolling **beta** for the **five countries** with the largest securitized **real** estate market capitalization. There is a **clear** downward trend in the beta for the U.S., the U.K. **and** Japan, and at the end of the period under review the beta is only in **the** 0.2-0.5 range. These lower betas **confirm** the results of previous studies for the U.S. market. The beta for Hong Kong **real** estate securities is high **and** remains high over the period. This is not surprising as **real** estate securities represent a large **fraction** of the Hong Kong stock market (32.6% on **average** over the analyzed period). For Australia, the end of period beta is approximately at the same **level** as that at **the beginning** of the period (0.4-0.5 range), **with** a steady increase followed by a steady decrease in years 1997-2001. Overall, the betas for **real** estate securities are low **and** have a tendency to decline over the period.

**< INSERT FIGURE 3 HERE >**

The cross-country correlation coefficients are reported **in Table 2 (Panel A** for **real** estate stocks, **Panel B** for stocks). As reported by Eichholtz (1996a), the correlations are **smaller** for **real** estate stocks than for common stocks, suggesting greater benefits from international diversification for **real** estate stocks **than** for stocks. It is interesting to examine whether **such** correlations are **time-varying**. For that purpose, the 36-month rolling **average** correlation coefficients are depicted in *Figure 4*. The **average** correlation for stocks is increasing, while **the average** correlation for **real** estate stocks is **quite stable**<sup>2</sup>. In **all** cases, the **average** correlation for **real** estate securities is lower than that for **stocks**<sup>3</sup>. Hence **the** international stock **markets** are becoming increasingly integrated which is not the case of **real** estate security **markets**. **When** cross-continent relationships are **considered**<sup>4</sup>, it is **found** that the correlation coefficients between **real** estate stocks **across continents** are lower **also** than the **average** correlation between common stocks **across continents**. The results **also** show a growing **integration** of **the** stock market, but contrary to **the** cross-country **analysis**, the correlation coefficients between **real** estate stocks **across continents** are rising over the period, albeit at a **much** lower **rate** than that of common stocks. Although we do not investigate the **diversification benefits** of international diversification in a formal way, these results **constitute**

<sup>2</sup> Eichholtz (1996b) tests the stability of correlation coefficients over **time** for nine countries and **also** concludes **that** correlation coefficients are **quite stable**. A **reverse** conclusion is found for variances and covariances.

<sup>3</sup> The same conclusion is **found** **when** returns by continent are used, **although** the **difference** in correlation **between** stocks **and** **real** estate stocks is not as marked as **when** returns by country are **used**.

<sup>4</sup> The figures are not reported in **this** paper, but are available **from** the authors.

tentative **evidence** on greater benefits **from international** diversification on the securitized **real** estate market than on the common stock market.

**<INSERT TABLE 2 HERE >**  
**<INSERT FIGURE 4 HERE >**

Finally, *Figure 5* shows **the** increase in the tracking error for a portfolio manager **when** he or she includes **real** estate stocks in **his/her** portfolio. For **an** allocation of 15% in **real** estate securities, the tracking error is in the 2-3% range. This should be a more than **acceptable** level of relative risk if the portfolio manager has strong convictions about **any** of the sources of the return generating **process** for **real** estate stocks. These sources **may include** a general **world-**wide **real** estate factor, **country** factors, **size** and **value/growth** factors, but **also specific** views on **real** estate stocks. In particular, in a bearish market for common stocks, a portfolio manager **may** have a **higher** expected return for **real** estate stocks, as a world-wide **asset class**, than for stocks. The low **betas** between **real** estate stocks and common stocks shown in *Figure 3* suggest that **during such times** diversification through **real** estate securities is especially **beneficial**, and *Figure 5* suggests that even within reasonable levels of tracking error the allocation to **real** estate **may** be substantial.

**<INSERT FIGURE 5 HERE >**

**4. Assessing the Risk of Real Estate Portfolios**

**4.1 The Model**

Modern Portfolio Theory (MPT) **provides us with the theoretic** tools to estimate **an** asset's, and hence a **portfolio's**, risk. On the one hand, we have **systematic** sources of risk (i.e. sources of risk that **influence** a large **number of assets**), and on the other we have the **stock's specific** risk. As these two sorts of risk are independent, the total risk of a stock or that of a portfolio is **simply** the sum of the two types of risk. **Systematic** risk originates from the behavior of the common factor(s) influencing the returns. In the case of the **Capital Asset Pricing Model (CAPM)**, the common factor is the market return in **excess** of the risk **free rate**, while in multi-factor models a larger number of common factors determine the total level of **systematic** risk.

Determining the common factors in a multi-factor model **may** be done using a variety of techniques, depending on the initial assumptions. **All** models have in common that there are common factor returns and factor loadings, i.e. the exposure of **each** stock to **each** factor. We **may** either observe factor returns and estimate the factor loadings (**such** as in the CAPM, **where** the betas are the loadings), observe the loadings and estimate the returns (loadings are usually country or sector dummy variables), or estimate both the loadings and the factor returns (as in the **Arbitrage** Pricing Theory, APT, **class** of models).

Extending **the** model developed by **Heston** and Rouwenhorst (1994)<sup>5</sup>, **the** model we **propose** in **this** paper is based on observed exposures, and the factor returns are estimated. The idea is that the considered factors are “pure” in the sense that they are not influenced by **any** of the other factors. For instance, the “pure” U.S. factor represents what is really due to the **fact** that a stock is U.S. based. If there are more growth or value stocks, or more large or small **caps** in the U.S. than world-wide, then that growth or **size** effect **will** be **captured** by the corresponding “pure” factors, and hence the country factors **will** not be influenced by these dimensions. There is **also** a “common factor”, which is the factor to which **all** stocks are exposed. Formally, the model is **written** as follows:

$$R_{i,t} = F_t + \sum_{k=1}^K D_i^k \times F_t^k + p_{it}^G \times F_t^G + p_{it}^V \times F_t^V + S_{i,t} \times F_t^S + \epsilon_{i,t}, \quad (1)$$

**where**  $R_{i,t}$  is the return on stock  $i$  at **time**  $t$ .  $K$  is the number of countries.  $D_i^k$  is a dummy variable, set to one if stock  $i$  belongs to country  $k$ , **with**  $k = 1, \dots, K$ .  $p_{it}^G$  and  $p_{it}^V$  are the Salomon Smith Barney’s (SSB) **Growth** and Value probability weights of stock  $i$  at **time**  $t$ .  $S_{i,t}$  is the **size** exposure of stock  $i$  at **time**  $t$ . In the above equation, the **unknowns** are  $F_t$  (*the* return on the common factor, which is equivalent to the weighted **average** of **all** real estate stock returns),  $F_t^k$  (*the* returns on the “pure” country factors),  $F_t^G$  and  $F_t^V$  (*the* returns on the “pure” growth and value factors), and  $F_t^S$  (*the* return on the **size** factor). **Finally**,  $\epsilon_{i,t}$  is the

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<sup>5</sup> **Heston** and Rouwenborst (1994) **assess** the relative **importance** of diversification by country and by **industry** for international common stock portfolios. Country **and** **industry** dummy variables are used. A **similar** methodology is used **to** investigate the **benefits** of sector **and** **regional** diversification for U.S. private **real** estate portfolios by **Fisher** and **Liang** (2000), **and** for U.K. private **real** estate portfolios by Lee (2001).

stock-specific return, which means the return on stock  $i$  at time  $t$  once its country, value/growth and size attributions are taken into account.

The above model is estimated under the constraint that for the benchmark portfolio (the portfolio containing all real estate stocks in the SSB universe weighted by the relative market caps), the value weighted sum of exposures to factors (except to the common factor) is equal to zero. In other words, the benchmark portfolio does not have any global country exposure, nor any exposure to growth, value and size. This translates into the constraints:

$$\begin{aligned} \sum_{i=1}^N \sum_{k=1}^K w_{i,t} D_i^k F_t^k &= 0 \text{ for the country exposures,} \\ \sum_{i=1}^N w_{i,t} (p_{it}^G F_t^G + p_{it}^V F_t^G) &= 0 \text{ for the value and growth exposures, and} \\ \sum_{i=1}^N w_{i,t} S_{i,t} &= 0 \text{ for the size exposure.} \end{aligned} \quad (2)$$

Recognizing that, by definition,  $p_{it}^G = 1 - p_{it}^V$ , we may simplify equation (1). Furthermore, each stock's exposure to size is a transformation of its relative market weight  $w_{i,t}$ , such that the exposure to size of the largest property stock in the universe is equal to one.<sup>6</sup>

In order to estimate equation (1), we have to make sure there are enough representative observations for each country. For instance, if there is a single real estate stock in a given country, then estimating a "pure" country effect would not be relevant (in fact, the country factor would also pick up the specific return). We therefore require that there be at least five stocks belonging to any country for any given month. If there are less than five, then the country is dropped and the corresponding real estate stocks have no country exposure (in which case part of the country effect, if there is any, will be found in the real estate stock's specific return  $\epsilon_{i,t}$ ). Finally, equation (1) is estimated using a value-weighted OLS regression scheme, such that  $\sum_{i=1}^N w_{i,t} \epsilon_{i,t} = 0$ . The latter ensures that a large cap real estate stock has a larger effect than a small cap one. The equation is estimated in a cross-sectional way, that is,

<sup>6</sup> It can be shown that for the size variable we have to set a scaling arbitrarily. Indeed, we may have very small stock exposures and a large return on the size factor, or large stock exposures and a small return on the size factor. The constraint that the largest stock has an exposure of one yields a better economic interpretation of the returns on the size factor.

each month, the regression is performed and the factor returns at that time estimated, independently from observations for other time periods.

#### 4.2 Additional Factors

The cross-section regression in equation (1) decomposes the return on an asset  $i$  at time  $t$  into returns on the various factors, and an error term denoted  $\epsilon_{i,t}$ . This term represents the return that cannot be explained by the common factor and “pure” factors, and is therefore also referred to as the stock’s specific return. The specific returns may, of course, be influenced by other “common factors” that are not included in the model. For instance, as model (1) does not account for the various property types in which real estate companies invest, it could be that the specific returns on all real estate stocks of a given property type move together during a given month. As was mentioned, information about property types is not available from this database, but there may also be other common characteristics among real estate stocks. It is therefore of interest to extract these “hidden” factors from the specific returns. This is also the basic technique underlying APT models.

We argue that although it may be difficult to find an economic interpretation for such statistical factors, they are of foremost importance to the portfolio manager. If some stocks behave differently because they have an exposure to some statistical factor, and if the return on that factor is statistically and economically important, then a portfolio manager should actively manage the portfolio’s exposure to that factor. If he/she does not have a specific view on the expected return on the factor, he/she should make sure that the portfolio has the same exposure to that factor as the benchmark. If he/she does have a view, on the other hand, then he/she may bet on the performance of the factor by over-weighting (relative to the benchmark) the exposure of the portfolio to that factor. Not doing so will inevitably result in higher tracking error for the portfolio, without a higher expected return. This is an important issue in active management, and whether a factor is merely a statistical one (without economic interpretation) or not, is of little relevance here.

The most straightforward way to extract statistical factors is Principal Component Analysis (PCA). The matrix of variances-covariances or correlations is computed from the data, and through decomposition of eigen-values / eigen-vectors, orthogonal factors are obtained that fully explain the data structure. It is a powerful technique, but it uses the variance as the

measure of risk, and therefore assumes normality of the data. This **may** be a strong assumption **indeed**, and therefore we develop **also** an alternative technique, based on cluster analysis, that **makes** no distributional assumption.

Cluster analysis allows to form groups of observations, the degree of similarity of which is similar within **each** group, but dissimilar **across** groups. **Once** the membership of **each** stock to a cluster is determined, we **calculate** the **average** return of **all** observations within **each** cluster. These are the factor returns, and **each** stock has an attribute (one or zero) for **each** cluster. In the case of **the** PCA, the factor returns are the orthogonal PCA factors, and a stock has **any** exposure, either positive or negative, to **each** of the factors.

Applying cluster or PCA techniques to a set of data **will** always reveal some kind of *ex post* **structure** in the data. What is important, **however**, is the *out-of-sample* usefulness of the techniques. We apply therefore the following estimation procedure: we use the first 36 **months** of returns on **all assets** for which we have returns for **all** months, apply either the cluster algorithm or PCA, and measure the equally-weighted **average** return within **each** group over the subsequent 12 **months**. We then move **the** estimation window forward by 12 months, and re-estimate the groups. If **the Clustering** or the PCA approach had no predictive power (in other words, if the membership of **each** stock to a particular cluster, or the loading of **each** stock to a PCA factor were highly unstable over **time**), then there would be no reason to **expect any out-of-sample difference** in estimated factor returns.

The next **section** contains a discussion of our results.

## **5. Results**

### **5.1 Common Factor and “Pure” Factors**

*Table 3* contains summary **statistics** for returns on the common factor, returns on the “pure” country factors for the 10 **countries** with the largest securitized **real** estate market capitalization, returns on the “pure” growth factor, and returns on **the** “pure” **size** factor. By construction, the **average** return on the common factor is the **mean** return on the market weighted world index of **real** estate securities (the small **difference** is due to rounding errors). The countries **that** experience a high (low) **average** return during **the** period generally **also**



have a high (low) **average** return on **the** “pure” country factor, i.e. there is a wide discrepancy in returns **across** countries even **after** controlling for the common factor **and** the “pure” growth and **size** factors. There is a strong positive “pure” country effect in Hong Kong, while the country effect is not surprisingly **very** negative for Japan. The number of observations is not equal to 147 for **all** countries, as a country is only considered if there is a minimum of five **companies** in **any** given month. Caution must be exercised **when** interpreting the results of countries for which there is not a minimum of five **real** estate securities in **any** given month **during** the entire period (i.e. the Netherlands, Canada, and Sweden).

< INSERT TABLE 3 HERE >

The return on the “pure” growth factor is negative on **average**, indicating that **real** estate securities that have a large growth weight are negatively **affected** over the period. The **average** return on **the size** factor is positive: **all** things held constant, large capitalization **real** estate stocks **perform** better than smaller capitalization **real** estate securities. Hence, **much** of the effect of **size** that has been reported in the literature **may** not be related to **size**, but to country **and/or** style **effects**.

*Table 4* contains the correlation coefficients between the common factor and “pure” country, growth and **size** factors. The correlation **coefficients** between “pure” country factors, and growth and **size** factors are close to zero. This **indicates** that if **an** active portfolio manager **makes** a bet according to **any** of the **three** factors (country, growth, or **size**), this does not **imply** that he or she is **making** simultaneously a bet according to **any** other dimension. For instance, if one believes that a country **will** perform **well** in the future and a decision is made to overweight this country, **this** does not imply **that** this decision will have **an** impact in terms of the exposure to growth or **size**. This discussion is of course based on “pure” factors. In reality, it is not possible to gain exposure to the “pure” factors, but **rather when** a decision is made for **instance** to overweight one country, then this **will** not have in most cases a **neutral** effect on the growth and **size** exposures. To **overcome** this **difficulty**, constrained optimization techniques **may** be used to construct a model portfolio that takes **active** bets on **specific** “pure” factors, while keeping the exposures to other factors **neutral** (relative to the benchmark).

< INSERT TABLE 4 HERE >

Correlation coefficients between “pure” country factors are generally low. This is particularly true between the returns on the “pure” Hong Kong factor and the returns on the “pure” factor for several other **countries**. In **fact**, **many** of these correlations are negative. On the other hand, the returns on the “pure” country factors are highly correlated in **two** instances (Hong Kong and Singapore, and **France** and **the** Netherlands). This **may indicate** that **diversification** opportunities exist primarily **across** continents, and to a lesser extent only within continents (see **also** Eichholtz et al., 1998).

The “pure” factor approach that we use has important implications for portfolio management. The **active** portfolio manager will have to **decide** according to which factor he or she wants to make a bet. If **countries** with positive expected returns and low cross-country correlation coefficients are **selected** for **instance** (in most cases, **this will** imply selecting stocks of companies in different continents), he or she has to make sure that this strategy is **neutral** with respect to the growth and **size dimensions**. Alternatively, it could be decided that **an** investment in high growth or large **size real** estate companies should be emphasized. If the “pure” factor approach is not used, **such** strategies **will almost** certainly involve **making implicit** country bets simultaneously. With the “pure” approach, the **effects** of **such** strategies on the exposure to “pure” country factors as compared to **that** of the benchmark **can** be minimized.

*Figure 6 depicts* the rolling **average** of cross-country correlation coefficients for the 10 countries **with** the largest securitized **real** estate **market**, both for **raw** and “pure” country returns. The **average** cross-country correlation coefficients on the “pure” country factor returns are **much** lower than the **average** correlations on **raw** returns, and are **very** close to zero. The lower correlations would be expected as **the** common factor, which obviously has a positive effect on the correlation, has been **extracted when** returns on “pure” factors are used. **Both** sets of rolling **average** correlation coefficients are stable during **the** period. The low cross-country correlations on **raw** returns suggest substantial benefits **can** be obtained **from** diversifying a portfolio of **real** estate stocks internationally.

**< INSERT FIGURE 6 HERE >**

It is now interesting to focus on the cumulative returns for the various factors. *Figure 7* depicts the cumulative logarithmic returns for the common factor and the “pure” growth and size factors, while *Figure 8* shows the cumulative logarithmic returns for the “pure” country factors. There is a strong upward trend in cumulated returns for the common factor, with two slumps. The cumulative returns for the size factor are also rising. The returns on the size factor appear to be important, and large stocks are more exposed to this factor than smaller ones. As explained in section 4, the maximum exposure to size is for the largest real estate stock in the sample at any given month (size exposure = 1). For smaller stocks, the exposure is less, and even negative for many stocks as by construction the weighted average of the exposure to size is zero. As would have been expected, the cumulative returns for the growth factor pick up in the second half of the 1990s, but all of this increase vanishes in the beginning of the current decade. The cumulative logarithmic returns for the “pure” country factors shows that the Hong Kong securitized real estate market performed very well over the period, while the Japanese real estate stock market declined substantially as did the overall stock market (*Figure 8*).

< INSERT FIGURE 7 HERE >

< INSERT FIGURE 8 HERE >

Of particular interest is to analyze the importance of the market cap weighted average absolute returns on the common factor, the “pure” country, size, growth and value factors, and the specific component as a percentage of the total of these absolute returns. The relative importance of each factor and that of the specific return component is depicted in *Figure 9*. Of the traceable factors, the (weighted) average “pure” country factor appears to be the most important, but its importance has diminished slightly during the period. A large fraction also stems from the common factor. Growth did not have a large influence on real estate security returns at the beginning of the 1990s, but the importance of this factor has grown substantially during the period. As of the end of the period, the growth and value factors appear to be more important than the country factor. There is thus clearly a growth/value factor in real estate securities, and that factor should be taken into consideration when building real estate stock portfolios. The importance of size has diminished slightly over the period, and remains rather marginal. The specific component represents a large fraction of total absolute returns, and its share varies somewhat during the period. This indicates that stock picking remains a very important issue when constructing real estate security portfolios.

**<INSERT FIGURE 9 HERE >**

The SSB database **makes** it possible to extract a common factor and “pure” country, growth and **size** factors, and to ascertain **the** relative **importance** of these factors. Several other characteristics that are not included in this analysis should have **an** impact on **real** estate security returns. Examples of **such** characteristics are tax status, type of company (investment, trading, or development), investment focus (residential, **offices**, retail, etc.), and leverage. The impact of these characteristics **will** not necessarily be included in the specific return. **Indeed**, characteristics of **real** estate companies **that** are **specific** to a country **will** have been included into the “pure” country factor. This will be the case for **instance** of the tax status, which **will** apply to **all real** estate companies in a given country. Some type of company and investment focus effects **will also** be captured by **the** country factors if there a predominant type of company **and/or** focus in **any** given country. Similarly, if some omitted characteristic of **real** estate securities is related to the growth or the **size** characteristics, then it will have been captured by these factors. **Leverage** for **instance** should be captured by the growth factor as one of the variables that is used by SSB to measure **the** growth characteristic is the **internal** growth **rate** calculated **from** the Return on Equity (ROE). **Leverage** should have **an** effect on ROE, and hence increase the growth exposure of the company. Type of property and investment focus should **also** partly be captured by the growth and **size** characteristics. Developers should have a stronger growth component for instance. The specific factor **will** thus Capture **any** remaining effects, as **well** as **the** true specific component. In the next **section**, we **analyze** whether it is possible to extract **an** additional factor **from** the specific component that remains **after** taking into consideration the common factor and “pure” country, growth and **size** factors. For this purpose, we use cluster analysis techniques and **principal** component analysis.

## **5.2 Additional “Hidden” Factors**

The **clustering** algorithm used in this study **can** be summarized as follows: **k-means clustering** is applied iteratively on the **N-by-T=36** dataset of logarithmic **asset** returns **until** the largest group **contains** approximately 50% of the observations. This **first** cluster is referred to as “Cluster 1”. The two next retained clusters are the **ones** that **contain** the **second** and third largest number of observations, respectively. Finally, the final cluster (Cluster 4) contains **all**

other observations. From one estimation period to the other (which is moved forward by 12 months **each time**), we make sure **that** Clusters 2 and 3 correspond to the same clusters as in **the** previous estimation period by measuring the correlation over the 24 overlapping months of **the** estimated factor returns. If necessary, we adjust the memberships. With this procedure we make sure that the created clusters have some desired characteristics:

the first cluster contains approximately 50% of the observations and should correspond to what is observed most of the **time** for specific **real** estate stock returns;

Clusters 2 and 3 **contain** a reasonable **number** of stocks that behave in a **very** specific way;

Cluster 4 contains **all** other stocks. This is probably the least homogenous factor.

The results are represented in *Figure 10*, which shows **the** cumulated logarithmic returns on **all** four cluster factors. Not surprisingly, Cluster 1 shows little variability over **time**, although *the trend over the almost 10-year out-of-sample* period is positive. It is probably **also** the least interesting cluster to analyze, as by construction it contains most of the observations. Cluster 2 is clearly more variable, and its returns are economically important: drop of approximately 15% **during** year 2000, positive return in **excess** of 15% in 2001. Cluster 3 is highly volatile in 1997 and 1998, while little effect **can** be seen during the rest of the period. Finally, Cluster 4 shows mostly negative returns, especially **during** the **second** half of the sample period.

**<INSERT FIGURE 10 HERE >**

Clearly, the constructed clusters behave differently, not only *in-sample*, but **also out-of-sample**. From a portfolio management point of view, it is important to measure the risk of being over- or **under-exposed** to these factors, relative to the benchmark. A portfolio manager **who picks** stocks that belong, by **chance** and without **the** manager being aware of it, to Cluster **4** would significantly lower **his/her** portfolio return. This is important, even if it is difficult to attribute **any economic** “label” (**such** as a property type, for instance) to a cluster factor.

*Figure 11* shows the percentage of **real** estate stocks that change cluster **every** year. The figures are **quite** high, but this is due in part **to the fact** that a cluster membership **can** only be given to stocks **that** have been in the database for at least 36 months, at **any** point in **time**. A

new stock **will** increase the percentage of stocks changing clusters. A **real** estate stock that **merges** with another company or changes its SEDOL code for some other reason **will also** increase that percentage.

**<INSERT FIGURE 11 HERE >**

The second approach is PCA. We arbitrarily set the number of PCA factors to three (results for other numbers of PCA factors are available **from** the authors), and apply the same *out-of-sample* approach as with the cluster analysis: the **first** 36 months are used to **compute** correlations **from** the available specific **real** estate stock returns (in logarithms). These correlations are used to estimate the three PCA factors along with the factor loadings. The *out-of-sample* performance on the three factors over the subsequent 12 months is reported. The estimation window is **then rolled** forward by 12 months. Correlations over the overlapping 24 months are again calculated to rotate **and/or** permute factors to ensure continuity. The results are reported in *Figure 12*. The **first** PCA factor has a surprisingly **strong uptrend** over the full period. The magnitude of the factor returns is large. The second PCA factor has a zero return over the **10-year** period, but during that period the cumulated return (in logarithms) ranges between -120% and **+50%**. The magnimde of the returns is large again. The last PCA factor has **also** a large variability.

**<INSERT FIGURE 12 HERE >**

The correlation coeffrcients between the PCA factors and the Cluster factors are given in *Table 5*. The correlations for **the** PCA factors are not zero because these are the factors measured *out-of-sample* (there is no reason to **expect** exact *orthogonality out-of-sample*). The low correlations, together with the large factor returns (especially for the PCA factors), make US believe that there are strong and persistent hidden factors in **the** specific returns. These factors **may** be linked to company **specific** characteristics, **such** as **the property** types **the companies invest** in, **the level** of leverage, other activities of **the firm**, but **also** geographical presence of the holdings (remember that this **will** not be picked up by the country factors, as these refer only to the country of origin of the company). There **may also** be a link between **the** statistical factors and macro-economic variables, **such** as GDP growth or interest **rate** changes.

< INSERT TABLE 5 HERE >

Finally, in order to assess the **economic importance** of the above methodology, we show in **Figure 13** the relative **importance** of the absolute return on the three PCA factors, as **well** as the absolute unexplained residual, as a percentage of the total. Between 30% and 40% of the total is explained by the returns on the **three** PCA factors. Without being a formal test, it sheds some light on what a portfolio manager, **who** is measured against a benchmark, might **expect** from applying a three-PCA factor decomposition of the **specific** returns: one third of the portfolio **specific** risk is explained by the common PCA factors, which is a risk that **can** be hedged simply by ensuring that the portfolio has the same exposure to these common PCA factors as the benchmark portfolio.

< INSERT FIGURE 13 HERE >

## 6. Concluding Remarks

The **benefits** of international **real** estate diversification have been **documented** in the literature, albeit to a lesser extent than for common stocks. We argue that while it is important to recognize **the** advantages of cross-country diversification, it would be at least equally important to isolate the effect of various factors on international **real** estate security returns. A low cross-country correlation **coefficient** between **real** estate securities in two **countries**, for instance, could be due to the **fact** that **real** estate stocks in both countries differ with respect to **size**, to their exposure to growth or value, or to **any** remaining **effects** **such** as their tax status or their investment focus. We use constrained cross-section regressions to disentangle a common factor, and “pure” country, **size**, and **value/growth** **effects**. It is found that the **value/growth** factor is **an** important determinant of **real** estate stocks returns, and that the **importance** of this factor is growing. Country factors are **also** important, while the effect of **size** remains marginal. Statistical analysis of the residuals **indicates** that additional “hidden” factors most likely exist.

An important **practical** implication of the **method** used in this paper is that **an** investor **can** **decide** according to what factors he or she wants to make bets. For instance, a bet **can** be made to overweight countries with high expected returns and low **cross-country** correlation coefficients (this **will** in most cases involve selecting **real** estate stocks **from** countries in

different **continents**), without simultaneously **making** a **growth/value** bet nor a **size** bet. For that purpose, an optimizer **can** be used to gain exposure to the **selected** countries, while **minimizing** at the same **time the difference** between the exposure of the portfolio to other factors and the exposure of the benchmark to these factors.



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**Table 1** Summary statistics for real estate compauies included in the Salomon Smith Barney (SSB) database, February 1990-April 2002

For each of the 21 countries included in the SSB database, for continental groupings, and on a world-wide basis, the following statistics are reported: annualized mean return, standard deviation, number of monthly observations, average number of stocks in the index, average growth exposure, average market capitalization, average market capitalization as a percentage of stock market capitaliation, current market capitalization (i.e. as of April 2002), current market capitalization as a percentage of stock market capitalization, and current market capitaliation as a % of total market capitaliation of real estate stocks.

	Annualized Mean	Standard Deviation	Monthly Observations	Average Number of Stocks in Index	Average Growth Exposure	Average Market Cap	(as percentage of MCAP stocks)	Current Market Cap	(as percentage of MCAP stocks)	Current Market Cap (P - tage of total)
United States	9.9%	13.0%	147	99.0	26%	61,584.5	1.2%	150,290s	1.7%	50.8%
Hong Kong	12.7%	30.6%	147	31.0	42%	36,460.3	32.5%	34,642.9	28.5%	11.7%
United Kingdom	5.5%	19.5%	147	32.3	23%	20,315.0	1.9%	29,871.7	1.9%	10.1%
Australia	7.7%	15.3%	147	19.4	24%	10,759.0	0.1%	25,263.8	11.3%	8.5%
Japan	-9.0%	33.6%	147	24.3	57%	20,455.3	1.5%	17,344.4	1.5%	5.9%
Netherlands	0.5%	13.0%	147	6.7	3%	5,240.3	2.4%	9,2546	2.7%	3.1%
Canada	-7.6%	21.8%	147	7.1	41%	2,885.4	1.4%	6,822.3	2.0%	2.3%
France	4.1%	14.6%	147	16.4	19%	5,865.4	1.9%	6,469.6	1.2%	2.2%
Singapore	1.2%	43.5%	147	10.8	41%	5,250.4	16.3%	4,457.9	7.4%	1.5%
Sweden	1.6%	35.8%	147	4.8	45%	1,266.2	1.3%	2,768.5	2.2%	0.9%
Spain	1.5%	28.7%	147	3.4	23%	1,559.1	1.6%	1,999.1	1.1%	0.7%
Switzerland	8.5%	17.1%	147	2.2	41%	627.1	0.2%	1,411.4	0.3%	0.5%
Germany	0.5%	22.6%	118	2.9	24%	1,465.5	0.5%	1,380.0	0.3%	0.5%
Austria	0.3%	16.9%	63	2.3	46%	493.7	5.1%	981.1	11.5%	0.3%
Belgium/Lux	-1.3%	16.5%	147	2.1	48%	525.3	1.2%	958.9	1.2%	0.3%
Ireland	-25.5%	52.5%	106	1.3	37%	371.5	1.6%	595.9	1.5%	0.2%
Italy	-26.5%	37.6%	123	2.3	23%	560.0	0.4%	555.4	0.2%	0.2%
New Zealand	-39.1%	41.8%	75	1.0	36%	141.2	1.6%	203.0	3.2%	0.1%
Denmark	-3.4%	30.0%	142	1.3	31%	252.7	0.8%	136.7	0.3%	0.0%
Finland	-3.9%	21.0%	46	1.0	26%	113.5	0.2%	126.9	0.1%	0.0%
Norway	0.0%	23.4%	70	1.6	02%	179.6	1.1%	77.0	0.3%	0.0%
WORLD	4.3%	16.5%	147	283.9	35%	178,480.9	1.8%	295,611.7	2.0%	
AMERICA	6.5%	12.9%	147	106.1	27%	64,469.9	1.2%	157,112.8	1.7%	53.1%
EURDPE	4.0%	14.6%	147	76.8	22%	37,942.6	1.4%	56,586.7	1.4%	19.1%
ASIA	0.2%	31.2%	147	81.1	48%	65,237.5	4.3%	56,445.3	3.9%	19.1%
OCEANIA	6.7%	15.5%	147	19.9	25%	10,831.0	7.7%	25,466.8	11.1%	8.6%

**Table 2** Cross-country correlation coefficients for real estate securities and common stocks, February 1990-April 2002

Cross-country correlations of monthly returns for both *real* estate securities and common stocks. The 10 countries with the largest securitized *real* estate market capitalization are considered (U.S., Hong Kong, U.K., Australia, Japan, Netherlands, Canada, France, Singapore, and Sweden).

**Panel A: Real estate securities**

	United States	Hong Kong	United Kingdom	Australia	Japan	Netherlands	Canada	France	Singapore	Sweden
United States	1.00									
Hong Kong	0.28	1.00								
United Kingdom	0.40	0.25	1.00							
Australia	0.29	0.41	0.30	1.00						
Japan	0.10	0.12	0.27	0.25	1.00					
Netherlands	0.28	0.22	0.38	0.41	0.20	1.00				
Canada	0.43	0.27	0.36	0.31	0.23	0.31	1.00			
France	0.19	0.18	0.45	0.32	0.25	0.58	0.19	1.00		
Singapore	0.38	0.78	0.27	0.39	0.28	0.28	0.33	0.18	1.00	
Sweden	0.20	0.19	0.39	0.35	0.21	0.34	0.38	0.27	0.20	1.00

**Panel B: Common stocks**

	United States	Hong Kong	United Kingdom	Australia	Japan	Netherlands	Canada	France	Singapore	Sweden
United States	1.00									
Hong Kong	0.55	1.00								
United Kingdom	0.65	0.48	1.00							
Australia	0.53	0.53	0.55	1.00						
Japan	0.37	0.32	0.48	0.44	1.00					
Netherlands	0.64	0.51	0.75	0.55	0.44	1.00				
Canada	0.78	0.62	0.50	0.61	0.37	0.56	1.00			
France	0.59	0.46	0.68	0.47	0.41	0.77	0.52	1.00		
Singapore	0.57	0.75	0.49	0.57	0.39	0.53	0.56	0.46	1.00	
Sweden	0.59	0.49	0.54	0.55	0.48	0.62	0.59	0.67	0.49	1.00

Table 3      **Summary statistics for the common factor and the “pure” factors, February 1990-April 2002**

Annualized mean return, standard deviation, and number of observations for the common factor, the “pure” country factors in the 10 countries with the largest securitized real estate market capitalization, the “pure” growth factor, and the “pure” size factor.

	Annualized	Standard	Number	Sum
	Mean	Deviation	Obs.	
Common Factor	4.3%	16.6%	147	52.9%
United States	5.0%	15.1%	147	60.7%
Hong Kong	9.5%	28.3%	147	116.8%
United Kingdom	-0.3%	15.8%	147	-3.3%
Australia	2.9%	15.5%	147	35.5%
Japan	-15.6%	29.9%	147	-190.8%
Netherlands	-1.4%	13.5%	94	-11.2%
Canada	3.5%	16.5%	68	19.8%
France	-1.2%	16.9%	147	-14.6%
Singapore	-1.0%	33.5%	147	-12.4%
Sweden	15.0%	19.7%	58	72.5%
Growth	-0.3%	5.8%	147	-3.5%
Size	2.9%	13.4%	147	35.3%

Table 4      **Correlation coefficients between the returns on the common factor and on “pure” factors, February 1990-April 2002**

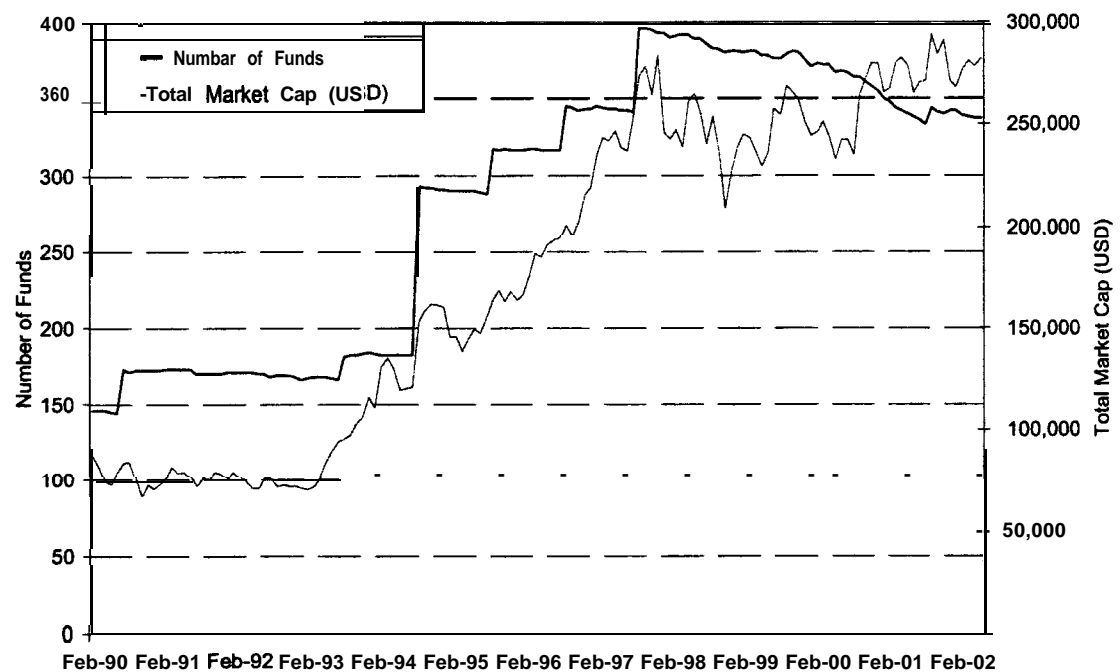
“Pure” factors are: country factors for the 10 countries with the largest securitized real estate market capitalization as of March 2002, a growth factor and a size factor.

	MONTHLY OBS	Common Factor	United States	Hong Kong	United Kingdom	Australia	Japan	Netherlands	Canada	France	Singapore	Sweden	Growth	Size
Common Factor	147	1.00												
United States	147	-0.64	1.00											
Hong Kong	147	0.39	-0.42	1.00										
United Kingdom	147	-0.29	0.25	-0.46	1.00									
Australia	147	-0.52	0.41	-0.22	0.11	1.00								
Japan	147	-0.03	-0.16	-0.39	-0.04	-0.03	1.00							
Netherlands	94	-0.54	0.25	-0.49	0.29	0.26	0.08	1.00						
Canada	68	-0.11	0.39	-0.37	0.16	0.24	0.00	0.12	1.00					
France	147	-0.80	0.39	-0.40	0.37	0.43	0.07	0.64	0.09	1.00				
Singapore	147	0.38	-0.27	0.62	-0.37	-0.16	-0.13	-0.49	-0.15	-0.34	1.00			
Sweden	58	-0.29	0.18	-0.52	0.49	0.39	-0.09	0.36	0.19	0.49	-0.57	1.00		
Growth	147	0.02	-0.02	0.06	0.12	0.00	-0.16	0.11	-0.05	-0.04	0.16	0.30	1.00	
Size	147	0.12	0.04	-0.03	-0.10	0.16	-0.03	-0.26	0.04	0.02	0.04	0.14	-0.09	1.00

**Table 5**      **Correlation coefficients between cluster returns and PCA returns**  
*The table shows the correlations over time of the “out-of-sample” Cluster and PCA factors. These factors are out-of-sample because the first 36 months (2/1990-1/1993) of data is used to estimate the first year of out-of-sample factor returns (2/1993-1/1994). The estimation procedure is then moved forward by 12 months.*

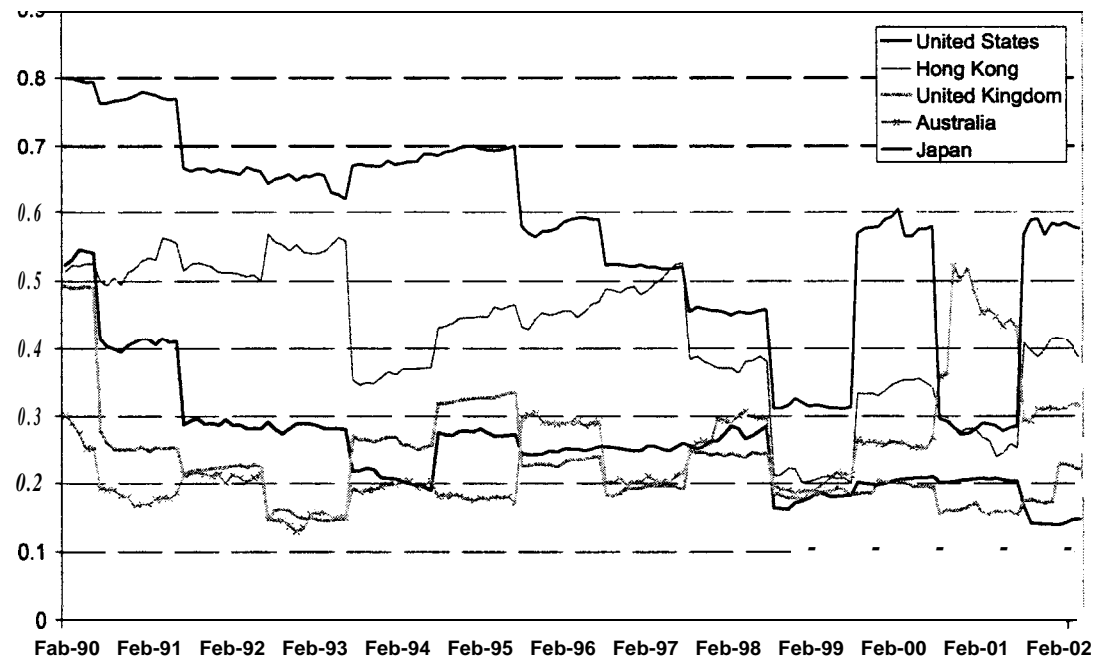
	PCA 1	PCA 2	PCA 3	LC_ST_ER1	CLUSTER 2	CLUSTER 3	CLUSTER 4
PCA 1	1.00						
PCA 2	-0.07	1.00					
PCA 3	-0.08	0.14	1.00				
CLUSTER 1	-0.16	0.25	-0.03	1.00			
CLUSTER 2	0.25	-0.31	0.29	-0.09	1.00		
CLUSTER 3	0.12	0.53	0.24	0.05	-0.07	1.00	
CLUSTER 4	0.12	-0.08	-0.19	-0.12	0.08	0.19	1.00

**Figure 1** Number of real estate stocks and market capitalization of real estate stocks included in the SSB database, February 1990-April 2002



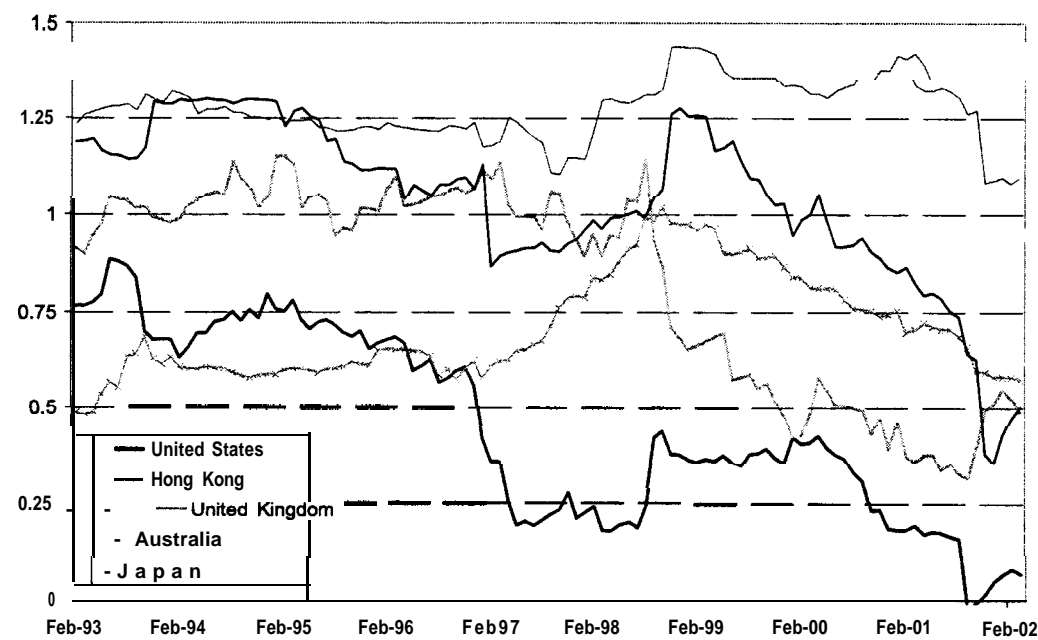
**Figure 2** Average growth exposure for real estate stocks in Europe, Asia, North America, Oceania, and the World, February 1990-April 2002

Growth exposure (on a scale from 0 to 1) as defined by Salomon Smith Barney (SSB). Five-year earnings per share growth rate, five-year sales per share growth rate and five-year internal growth rate are taken into account. Measure is relative to other stocks in the country or region and the sum growth rate and value weight for each stock is 1.



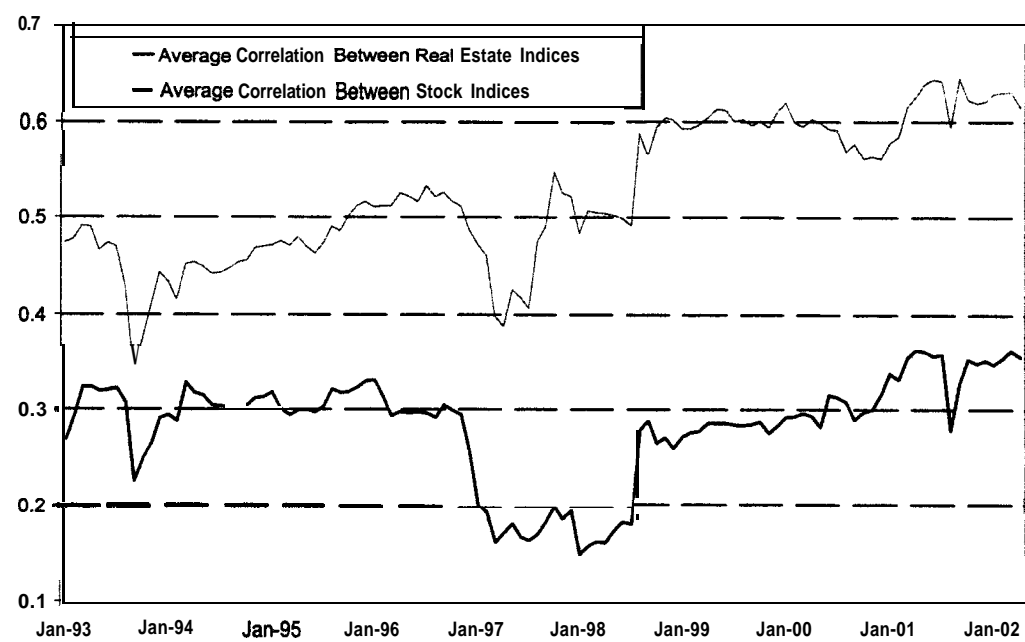
**Figure 3** Rolling betas of real estate stocks on common stocks for the U.S., Hong Kong, the U.K., Australia, and Japan, February 1990-April 2002

Rolling betas *calculated from regressions* of real estate stock returns on common stock returns *using 36-month windows*. The window is *shifted* by one month *for every* regression. The *first* regression covers the period 2/1/1990-1/31/1993, the *second* regression the period 3/1/1990-2/28/1993, and so on *until* the last regression for the period 5/1/1999-4/31/2002.



**Figure 4** Rolling average cross-country correlation coefficient for real estate securities and stocks, February 1990-April 2002

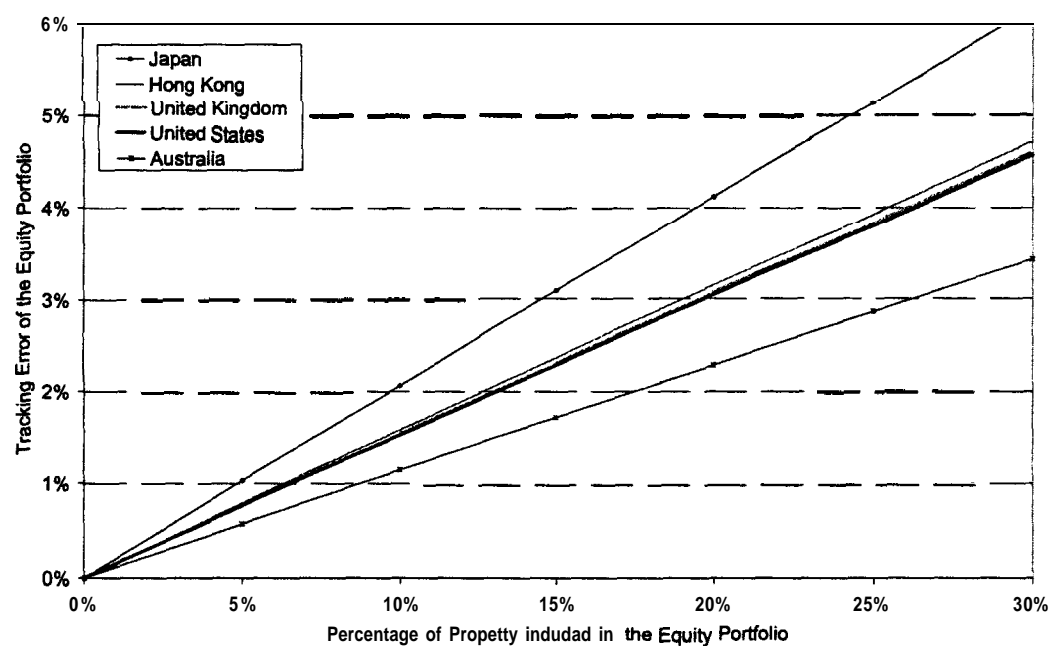
Rolling *average* correlation *coefficients calculated on 36-month windows*. The window is *shifted* by one month *for every* computation. The countries considered in the *average* are the 10 countries *with the largest securitized real estate market capitalization* (U.S., Hong Kong, U.K., Australia, Japan, Netherlands, Canada, France, Singapore, and Sweden).





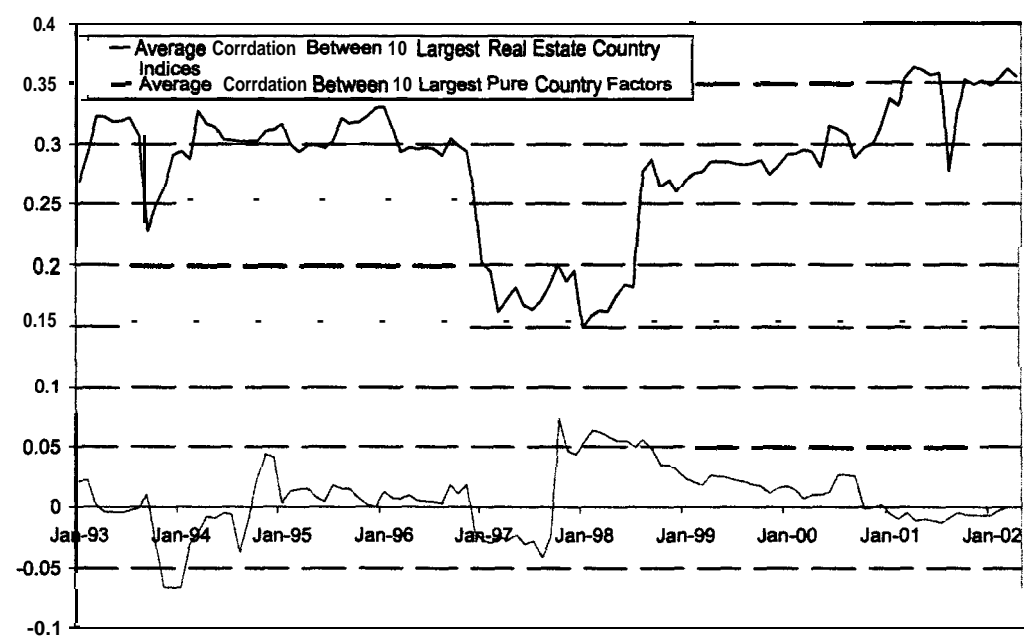
**Figure 5** Stock portfolio tracking error as a function of the percentage of real estate securities included in the portfolio (for the U.S., Hong Kong, U.K., Australia, and Japan)

The following example best explains the graph: if we add 15% of U.S. real estate to a U.S. stock portfolio, measured against a U.S. stock benchmark, then the tracking error of that portfolio is 2.3%. For all countries, the impact on the tracking error of adding real estate to a pure stock portfolio is very reasonable.

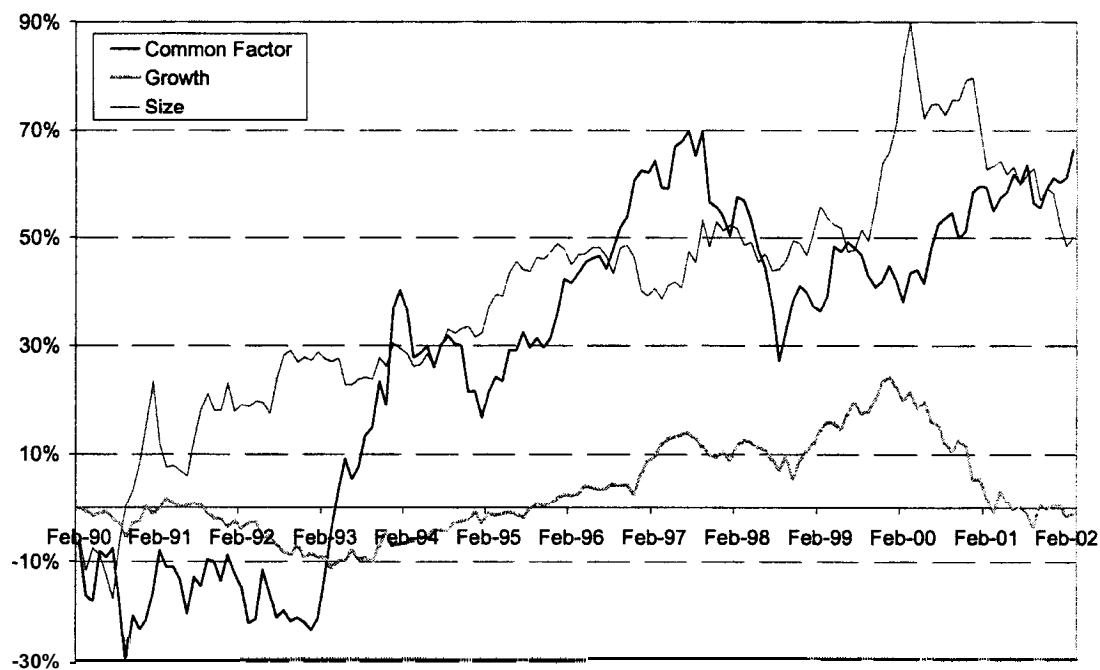


**Figure 6** Rolling average correlation coefficient for raw returns and returns on “pure” country factors, February 1990-April 2002

Average of cross-country correlation coefficients for the 10 countries with the largest securitized real estate market capitalization. 36-month rolling windows are used.

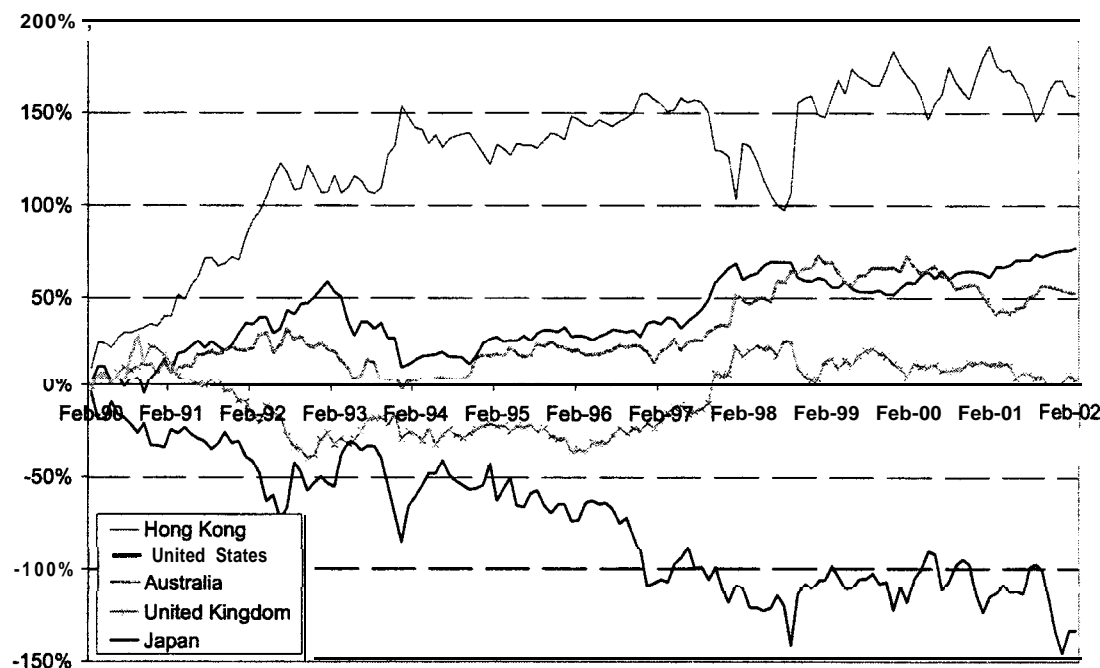


**Figure 7** Cumulative logarithmic returns on the common factor, the “pure” growth factor and the “pure” size factor, February 1990-April 2002



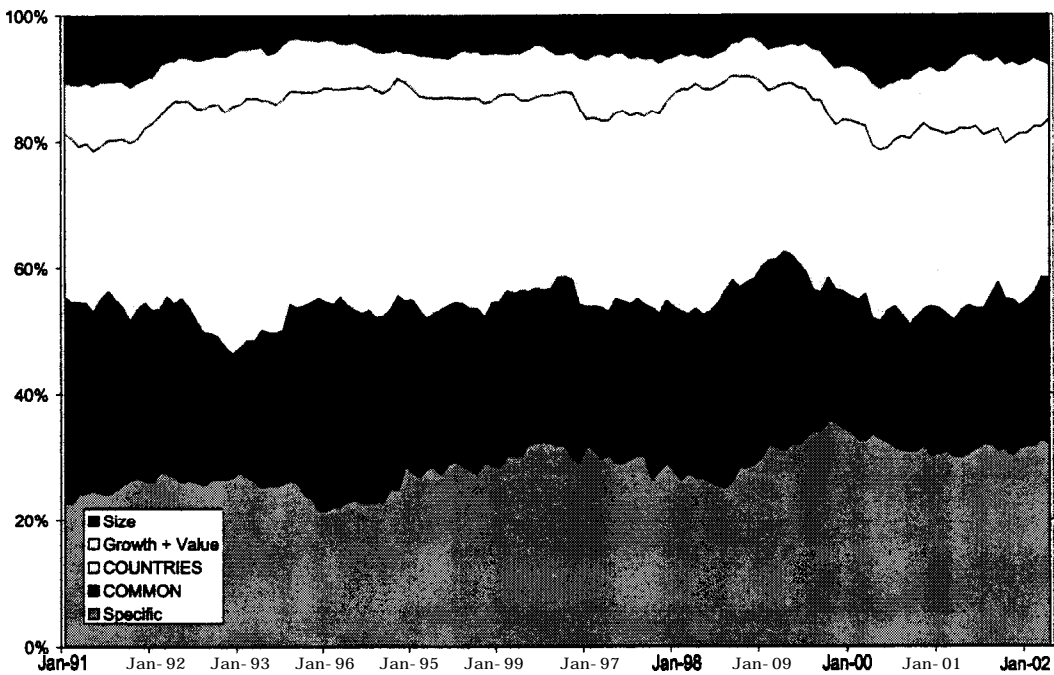
**Figure 8** Cumulative logarithmic returns on the “pure” country factors for the U.S., Hong Kong, U.K., Australia, and Japan, February 1990-April 2002

Cumulative returns on the “pure ” country returns are reported for the five countries with the largest securitized real estate market capitalization (U.S., Hong Kong, U.K., Australia, and Japan).



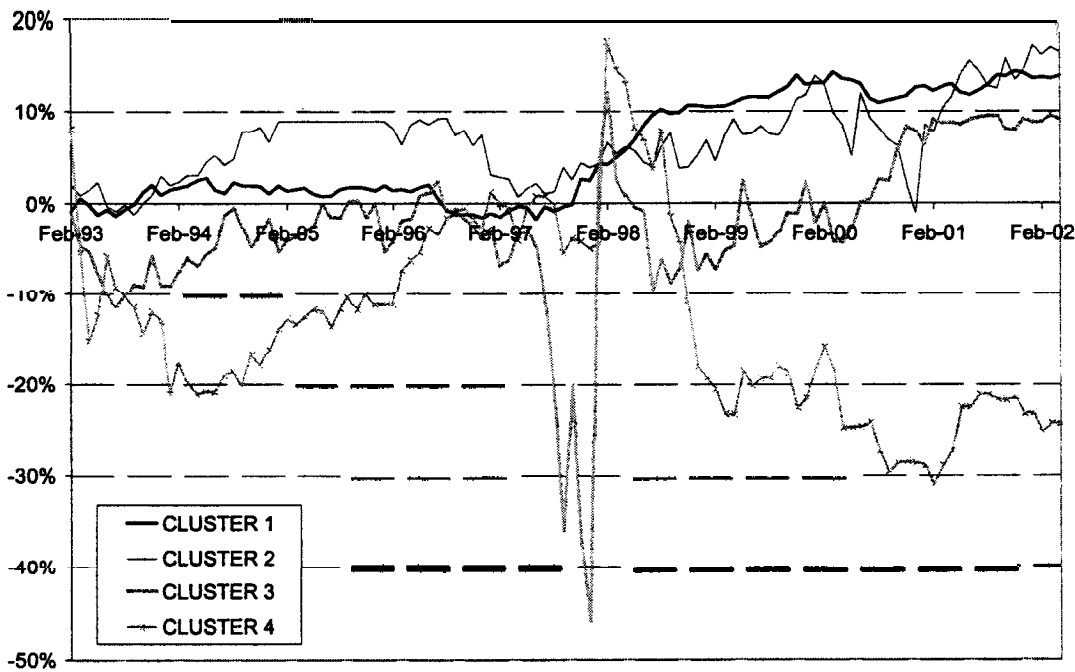
**Figure 9** Average absolute returns on each factor as a percentage of total absolute returns, February 1990-April 2002 (12-month moving averages)

Importance of the average absolute returns on the common factor, the "pure" country, size, growth and value factors, and the specific component as a percentage of the total absolute returns from these various sources.

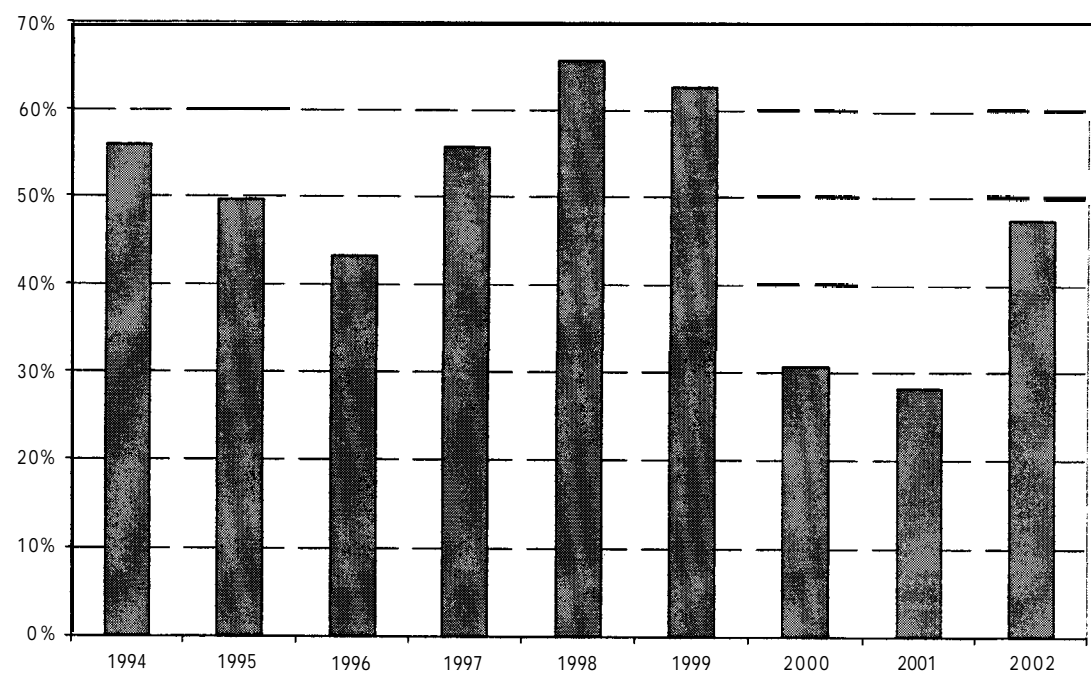


**Figure 10** Out-of-sample cumulative logarithmic returns on the four cluster factors, February 1993-April 2002

The first year of out-of-sample returns (02/1993 to 01/1994) are obtained through cluster analysis of the real estate returns from 02/1990 to 01/1993. The 36-month rolling window is then moved forward by 12 months to obtain the cluster factor returns over the full period.

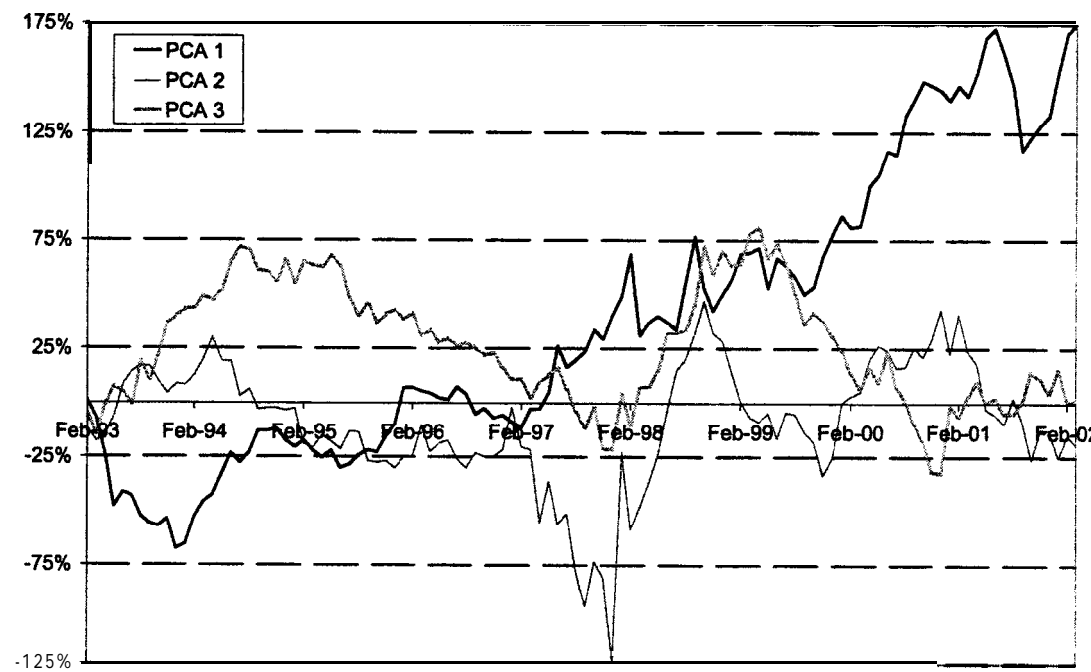


**Figure 11** Percentage of **real estate companies** having changed clusters from one year to another, 1994-2002



**Figure 12** Out-of-sample **cumulative** logarithmic returns on the three **components** from the **principal component analysis**, February 1993-April 2002

*The first year of out-of-sample returns (02/1993 to 01/1994) are obtained through PCA analysis of real estate returns from 02/1990 to 01/1993. The 36-month rolling window is then moved forward by 12 months to obtain the PCA factor returns over the full period.*



**Figure 13** Average absolute returns on **each** of the PCA factors and on the residual, as a percentage of total absolute returns, February 1993-April 2002 (12-month moving averages)

*Each stock's residual return is defined as its specific return, from which the returns on the estimated PCA factors (times each stock's sensitivity to each of these factors) is subtracted. A substantial percentage of the stock's specific returns can be explained by the three PCA factors (which are truly out-of-sample).*

